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REPORT OF THE TAC FACT-FINDING MISSION TO THE INTERNATIONAL FERTILIZER DEVELOPMENT CENTRE (IFDC)

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TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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ACRONYMS

ACFD	African Center for Fertilizer Development
ADAB	Australian Development Assistance Bureau
AFTMIN	African Fertilizer Trade and Marketing Information Network
APF	American Phosphate Foundation
ARS	Agricultural Research Service (USA)
BMZ	Bundesministerium für Wirtschaftliche Zusammenarbeit (FRG)
BSC	British Sulphur Corporation
CERES	Crop Evaluation through Resource and Environmental Synthesis
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIP	Centro Internacional de la Papa
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
DGIS	Directoraat Generaal voor Internationale Samenwerking (Netherlands)
EFDC	Egyptian Fertilizer Development Centre
FADINAP	Fertilizer Advisory Development and Information Network for Asia and the Pacific
FAI	Fertilizer Association of India
FAO	Food and Agriculture Organization of the United Nations
FEPIS	Fertilizer Advisory Development and Information Network for Asia and the Pacific
GTZ	Gesellschaft für Technische Zusammenarbeit (FRG)
IARC	International Agricultural Research Centre
IBSNAT	International Benchmark Sites Network for Agrotechnology Transfer
ICARDA	International Centre for Agricultural Research and Development in the Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Centre (Canada)

IFA	International Fertilizer Industry Association
IFAD	International Fund for Agricultural Development
IFDC	International Fertilizer Development Centre
IFPRI	International Food Policy Research Institute
IITA	International Institute for Tropical Agriculture
IMPHOS	Institut Mondial des Phosphates
INSURF	International Network on Soil Fertility and Sustainable Rice Farming
IRAT	Institut de Recherche pour l'Agriculture Tropicale
IRRI	International Rice Research Institute
NFDC	National Fertilizer Development Centre (TVA)
OACD	Office of Agricultural and Chemical Development
OAU	Organization for African Unity
OCLC	On-Line Computer Library Centre
OMD	Office of the Managing Director (IFDC)
PAPR	Partially Acidulated Phosphate Rock
PPI	Potash and Phosphate Institute
PR	Phosphate Rock
R&D	Research and Development
SCU	Sulfur-Coated Urea
STRC	Scientific Technical and Research Commission (OAU)
TFI	The Fertilizer Institute
TSP	Triple Superphosphate
TVA	Tennessee Valley Authority
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
USG	Urea Supergranules

TAC FACT-FINDING MISSION TO THE

INTERNATIONAL FERTILIZER DEVELOPMENT CENTRE (IFDC)

(Muscle Shoals, Al. (USA), 4-9 June 1989)

1. BACKGROUND

The International Fertilizer Development Centre (IFDC) has its Headquarters at Muscle Shoals, Alabama, United States of America (USA), adjacent to the National Fertilizer Development Centre (NFDC) of the Tennessee Valley Authority (TVA). In 1987 IFDC established an Africa Division with offices in Lomé, Togo. IFDC also has personnel located in Bangladesh, Colombia, Niger, Philippines and Zimbabwe.

1.1. A Brief History of IFDC

IFDC can be considered as an outgrowth of NDFC-TVA. In the early 1960s it became evident that the TVA fertilizer know-how and facilities were a resource that could be contributing to the foreign assistance efforts in the developing countries. TVA became increasingly involved in the third world. Initially, this involvement was in the form of furnishing information on fertilizers to USAID and its missions, but soon became direct by sending technical assistance missions to developing countries.

However, TVA was very restricted in what it could do for the developing countries. For example, TVA could not engage in research and development specifically for the developing countries, and could take on work only through the US Government (USAID or the Department of State).

Food shortages were occurring on a worldwide-scale basis in the early 1970s. Energy shortages were becoming commonplace and prices of fertilizers were increasing rapidly. In April 1974, Dr. Henry Kissinger, then Secretary of State, in an address to the United Nations General Assembly, pledged the availability of US know-how in fertilizers as well as strong material support toward the establishment of international action on two specific areas of research: improving the effectiveness of chemical fertilizers especially in tropical agriculture and new methods to produce fertilizers from non-petroleum resources.

The United States Agency for International Development (USAID) drew up a plan for an International Plant Nutrition Institute (IPNI). IPNI envisioned three programme components:

- work on chemical fertilizer;
- biological nitrogen fixation;
- the recycling and better utilization of organic wastes.

The Technical Advisory Committee (TAC) of the CGIAR briefly reviewed the IPNI proposal. It concluded that much could be done on chemical fertilizers in a short period of time, and urged USAID to move ahead on the first component.

The Board of Directors of TVA, in 1974, felt that it could go no further without new legislation and suggested that the new initiative take on a separate form. TVA pledged its full cooperation and its know-how in fertilizers and offered a site at its Muscle Shoals location so that close cooperation between its Office of Agricultural Chemical Development (OACD) and the new institution could be assured.

IFDC was created in 1974 and located at Muscle Shoals, Alabama. First set up as a non-profit organization under laws in the State of Alabama, designation as a an international non-profit organization was received in March 1977 by Presidential Decree 11977. The Muscle Shoals site adjacent to TVA had three important advantages:

- it made the transfer of US know-how from TVA easier;

- TVA had agreed to furnish IFDC at cost the chemicals for fertilizer manufacturing (phosphoric acid, sulfuric acid, nitric acid, urea solution, etc.); IFDC would thus not need to have its own plants nor have to build storage for these materials;

- IFDC was able to buy into or contract for a number of other facilities and services, not the least of which was to share the TVA Library.

The TVA site had almost all of the ingredients for IFDC to become fully operational in a short period of time and at a modest establishment cost. In July 1975 the international staff of TVA was transferred to IFDC to become the nucleus of IFDC. IFDC and TVA signed an agreement whereby TVA deferred to IFDC all fertilizer-related work in the developing countries and IFDC deferred all fertilizer work in the United States to TVA. The building programme was started at its present site in March 1976 and the total complex was available for occupancy in August 1977.

The USAID was the chief sponsor for the establishment of IFDC. The International Development Research Centre (IDRC) of Canada also functioned as a co-sponsor and provided the first financing (CDN$ 50,000) as a startup grant in 1974. Soon thereafter the USAID also contributed to the startup (US$ 250,000) in addition to providing the funds for constructing the IFDC facilities.

From its creation in 1974 IFDC has been considered for inclusion in the international agricultural research system supported by the Consultative Group on International Agricultural Research (CGIAR). In 1979, a panel commissioned by the Technical Advisory Committee of the CGIAR reviewed IFDC's programmes and activities to evaluate their appropriateness for inclusion of IFDC as a full member of the system of International Agricultural Research Centres (IARCs). The panel commended IFDC for support by the CGIAR. However, TAC did not recommend inclusion in the system of IARCs. In late 1979, the CGIAR at its annual meeting decided to defer its decision but invited IFDC to become an associate member - a status held by IFDC since that time.

1.2. IFDC's Mandate and Objectives

In the Articles of Incorporation, the purposes for which IFDC was established are defined as follows:

(1) To operate a worldwide centre for the collection and dissemination of information relative to fertilizer, for research and development in the technology, use, and marketing of fertilizer, for the training, advisory services and technical assistance in the production, engineering, marketing and use of fertilizer and for cooperation with the Food and Agriculture Organization of the United Nations, International Bank for Reconstruction and Development and organizations situated in foreign countries which are sponsored in whole or in part by the United States of America for the improvement of fertilizer technology and use to serve the needs of the developing countries with special emphasis on the tropics.

(2) To engage in other charitable, educational or scientific activities consistent with the foregoing purposes or necessary or appropriate for carrying out the same.

More specifically, IFDC's mandate is to focus on research, development and transfer of appropriate fertilizer technology and related know-how that can increase and sustain food and agricultural production in developing countries at the lowest possible cost. IFDC programmes in research, technical assistance and training are designed to achieve three major objectives:

- to improve efficiency in fertilizer production, procurement and marketing, and to increase the availability of appropriate fertilizers to farmers at the lowest possible cost while emphasizing the use of indigenous raw materials;
- to increase fertilizer-use efficiency in food production;
- to assist in the training of personnel needed in developing countries in the production, marketing and use of fertilizers.

1.3. IFDC's Clients

The final client of IFDC's efforts, to develop new and improved fertilizers and fertilizer know-how for the tropics and sub-tropics, is the farmer. The consumer of the increases in food, fuel, and fiber production will also benefit.

To develop a new or improved fertilizer requires many steps from the raw material to having the finished fertilizer in the hands of the farmer. Thus, there are additional actors that must all play their roles. These roles may be concerned with mining and beneficiation, processing, quality control, packaging, storage, transport, pricing and credit, purchasing, marketing, etc. Each step is a function that must be efficiently and timely carried out if farmers are to obtain their full measure of benefit from the fertilizers they use.

IFDC's staffing, its programmes of R&D, its training efforts and its technical assistance all recognize these co-partners without losing the focus that it is the farmer of the tropics and sub-tropics that is the ultimate client. The farmer must be successful if those in fertilizer production and marketing are to flourish.

2. THE CENTRE's PROGRAMME

2.1. IFDC's Strategy

In accordance with its mandate IFDC develops programmes that aim at impacting the fertilizer sector in developing countries. The majority of its core programmes have a global or regional focus; they are not meant to be specific to only one country but to have an impact in other countries within a region.

IFDC programmes have focused on: improving nitrogen efficiency, particularly in lowland rice; identification of technologies that will lead to the development of indigenous deposits of agrominerals, mainly phosphate rock; development and identification of fertilizer policies that will increase food production and support an equitable and sustainable agriculture; increasing the quality and size of the manpower base; establishing the data base and information networks that are necessary to operate an efficient fertilizer sector; and carrying out technical assistance that addresses investment strategies.

IFDC tackles its R&D, training and technical assistance using the multidisciplinary task team approach. For example, problems related to improving nitrogen efficiency may include a soil scientist, engineer, agronomist, economist, and modeler. Similarly, a training programme for a specific course will be designed and implemented by specialists from a range of disciplines with the manager of a particular course being alternated on a regular basis. This concept is equally applicable in carrying out technical assistance, particularly in sector studies.

Much of the research is tailored to fit specific agro-climatic zones (i.e., arid, semi-arid, sub-humid and humid areas) and socio-economic farm groups (high-, medium- and low-income farmers). By following this approach, IFDC aims at developing a family of technologies that fit specific agroclimatic or socio-economic areas.

2.2. The Constraints Addressed by IFDC

It is generally recognized that the efficient use of fertilizers, combined with other inputs such as better seed, plant protection, improved tillage and irrigation, plays a key role in increasing agricultural production.

However, serious constraints exist which are holding back efforts to enhance agricultural productivity and to bring it up to its potential in developing countries.

Among these constraints IFDC addresses the following:

- the inability of farmers to accept risks involved in agricultural experimentation and operation in more complex systems of agriculture;
- the lack of economic motivation for the farmer to use agricultural inputs;
- the inadequacy of some commonly available fertilizers under tropical conditions;
- the lack of information on improved ways of fertilizer production, storage and use;
- the lack of trained personnel in the national fertilizer sector;
- the lack of infrastructure, marketing and credit facilities.

IFDC aims at resolving these constraints through research, experimentation and the development of new forms of fertilizer, as well as expanding the use of current or improved fertilizer materials. In doing so it takes into account technical, economic and social factors. Where possible, production capacities are established using indigenous raw materials.

2.3. Programme Approach and Operation

IFDC recognizes that the efficiency of nutrient uptake from a fertilizer and the resulting effectiveness of that fertilizer depend upon interactions between the fertilizer itself and numerous other variables including soil properties, time and rate of application, climate, crop species, cultural practices, and management.

Fertilizer efficiency research therefore, if conducted with a simple source comparison approach, is site specific. This approach has been avoided to the extent possible by IFDC in its attempts to define appropriate fertilizer technologies for developing countries. Instead, IFDC has placed as its priority the development of methods with the potential to overcome specific mechanisms inhibiting efficient nutrient use commonly encountered in tropical and sub-tropical cropping systems.

With respect to agronomic efficiency, the standard research approach applied by IFDC in a given agroclimatic zone follows the sequence described below:

- IFDC scientists conduct research in collaboration with international and national institutions to determine the efficiency of fertilizer materials and practices currently being used within the region;
- based on the findings of the research on the fate of the nutrients and the pathways of nutrient loss, soil scientists and chemical engineers work together to formulate experimental materials;

- these experimental fertilizers are screened in IFDC greenhouse or growth chamber facilities to determine which of the alternatives are effective in achieving the desired results;

- if promising results are obtained with one or more of the modified products or practices, production of the materials with greatest potential is scaled-up to simulate commercial production conditions in IFDC's pilot plants;

- field evaluation of product management and effectiveness is conducted by IFDC staff members outposted in developing countries or by national institution collaborators participating in an IFDC research network. No field research is conducted at IFDC headquarters in Muscle Shoals. Research data is entered and stored in IFDC's fertilizer efficiency computerized data base;

- concurrent with the execution of the field experimentation on fertilizer management and effectiveness, socio-economic studies are conducted to identify potential constraints to future adoption of proposed technologies and to estimate potential impact if they are adopted;

- where production, market, and institutional issues are the central focus for a programme a multidisciplinary team is identified and will operate for a long or short period as the programme requires. In many cases such projects will also complement investigations of agronomic efficiency in fertilizer use.

2.4. Research

IFDC conducts the research on fertilizer use and efficiency from a multidisciplinary approach. Its programmes range from basic and adaptive to applied research, with a higher emphasis on the last two (Annex 2.4). IFDC has paid primary attention in its research programmes to three basic nutrients (nitrogen, phosphorus and sulfur) supported by a socio-economics/policy programme and a modeling programme. These five programmes cut across the Agro-Economic, Fertilizer Technology, Outreach and Africa Divisions. There are no formally designated programme leaders, however, each programme does have a leader de facto.

2.4.1. Nitrogen

The nitrogen programme focuses primarily on improvement of the crop-use efficiency of urea (the most common N source in developing countries). Work initially focused on (1) verifying the reportedly poor efficiency of N utilizations, and (2) identifying the causes for the poor performance of commercial N sources. Currently, emphasis is placed on development of technologies and management techniques to improve the efficiency of applied N and development of crop-growth simulation models.

Research on concepts of N-use efficiency in the N programme are split between laboratory, growth chamber, and greenhouse experimentation

at Headquarters, research station experimentation by IFDC staff outposted at IRRI, and field testing by a network of national institution collaborators.

Research in this programme has shown that, when urea is applied to the floodwater, significant losses of urea-N can occur via ammonia volatilization. The following solutions have been invstigated by IFDC.

2.4.1.1. Deep placement of urea supergranules

IFDC and IRRI have tested the use of large 1- to 2-grain urea supergranules (USG) to facilitate deep placement into the soil. Results from numerous field evaluations have shown that USG reduces N losses and increases N uptake by the rice. This technique shows a main drawback in that it requires line-transplanted rice and extra-labour associated with hand placement of the granules. IFDC scientists have recently developed a simple applicator to facilitate USG placement.

2.4.1.2. Urea supergranule production

Two methods have been studies by IFDC for making USG:

- Briquetting -- i.e. compaction of urea crystals, dust, or prills. It is a dry process requiring only a motor. IFDC engineers modified and demonstrated a small Chinese briquetter to enable the manufacture of locally-made USG and have collaborated with a West German company to test a commercial-scale briquetter. IFDC is currently working on a design of its own.

- Melt granulation -- IFDC has developed technology for making USG in a conventional rotary-drum and has collaborated with TVA in doing the same in TVA's falling curtain rotary drum.

An economical comparison of the above technique and other commercially available processes for the manufacture of USG shows that production by briquetting is favoured. No commercial production of USG yet exists, although interest has been shown in several developing countries.

2.4.1.3. Coating for controlled release

Compared with deep placement, this method does not involve changes in the farmers' practice. Several coatings have been tested by IFDC. None of them seem to be cost effective for rice farmers.

2.4.1.4. Inhibitors

A four-year project has been completed by IFDC on urease inhibitor synthesis, soil evaluation, and greenhouse and field trials. Over 40 possible urease inhibitors were synthesized or procured for evaluation. This work resulted in a patent, in a better understanding of the inhibitors' mechanism, and in the identification of powerful and stable inhibitors. Grain yields for rice in the greenhouse and field experiments have shown favourable results. Economical advantages of the method are not clear. IFDC is currently working with a commercial firm on a promising inhibitor.

2.4.2. Phosphorus

The objective of the P research programme is to assist developing countries in producing cost-effective P fertilizers using their indigenous resources where possible. IFDC tailors the technology to suit the need and to work within the constraints of the situation. IFDC focuses on P deposits that will serve a local or regional market.

IFDC does not attempt to make specific P rate recommendations for developing country agriculture. This is best left to the national institutions working on site. IFDC does, however, strive to identify the conditions which influence the effectiveness of P fertilizer and influence the decisions made by the national institutions. These factors are fertilizer properties, soil properties, management, and cropping systems.

The main thrusts of the phosphorus programme are (1) characterization of P deposits, (2) phosphate rock for direct application, (3) partially-acidulated rocks, and (4) multinutrient fertilizers.

2.4.2.1. Characterization

Characterization of a P mineral (ore or concentrate) consists of information on chemical analysis, mineralogical analysis, reactivity, grinding energy, assessment of impurities, particle size analysis, and potential for beneficiation (upgrading). This information is needed to plan a strategy for processing the material to a P fertilizer. IFDC has established a computerized raw material data file on about 1,200 P ore samples from 75 developing countries. New samples are added continually many of them from Africa. IFDC is the world's centre of excellence in characterizing and evaluating phosphate rock deposits.

2.4.2.2. Direct application of phosphate rock

IFDC is a leader in assessing P minerals for direct application to acid soils. The neutral ammonium citrate-soluble P_2O_5 in numerous samples has been determined and correlated with P recovered from soils after incubation, and with yields in numerous greenhouse and field trials. Phosphate rocks are ranked on the basis of low, medium, and high reactivity. Rocks ranking medium to high can be recommended, with a high degree of confidence, for direct application on acid soils. Ultimately, agronomic tests are needed to confirm the potential. Direct application products are applied in finely ground form (65% minus 200-mesh) or granulated with a binder.

2.4.2.3. Partially acidulated phosphate rocks (PAPR)

For those rocks or soil conditions not suitable for direct application, some type of acidulation must be considered. IFDC has concentrated its efforts on partial acidulation in order to reduce product cost by reducing the quantity of sulfuric or phosphoric acid for acidulation. The products may be granular or semigranular. Sulfuric acid has been used predominantly by IFDC since many developing countries do not have or cannot economically make phosphoric acid. The level of acidulation is 25% and 50%, indicating one-fourth or one-half of the sulfuric acid for full acidulation. Partially acidulated rocks are

about 2/3 as expensive as single superphosphate, but twice as expensive as ground phosphate rock. This type of technology is aimed for small countries having a limited demand for P and expensive raw materials. Sedimentary rocks low in reactivity can be used for this purpose. There is less agronomic experience in using low-reactivity igneous rocks for partial acidulation. The alternative or combining rock plus soluble P sources is being evaluated.

2.4.2.4. Multinutrient fertilizers

Multinutrient fertilizers encompass all those products containing more than one of the major nutrients (NPK). IFDC has gained experience in using urea in NPK formulations and is actively involved in advising developing country clients.

2.4.2.5. Due to a wide range of fertilizer sources and soils under evaluation, research has been conducted to improve field testing of plant available P. The result is a novel approach called the PI test.

2.4.3. Sulfur

Sulfur deficiencies in the tropics are so widespread that it can be considered a major element. IFDC's sulfur programme is based on the premise that an understanding of S transformation and loss mechanisms in various soil-plant systems is required in order to optimize S use efficiency and design more efficient S fertilizers; and, secondly, that nutrient S will in most situations be applied in combination with other nutrients (N, P, and K) rather than as a straight-grade fertilizer. Consequently, IFDC's sulfur programme focuses its activities on:

- the study of S dynamics in the soil-plant system as they affect the fate and efficiency of S-containing fertilizers. Work is focusing on organic-S pools, sorbed sulfur, leaching losses, immobilization/mineralization, and volatilization;

- the development and evaluation of S fertilizer sources and management strategies in which (but not exclusively so) S occurs in combination with other nutrient ions. Sulfatic sources are readily soluble but susceptible to leaching, while elemental sulfur is slowly soluble and must be oxidized to sulfate before they can be utilized by plants.

The immediate objectives of IFDC's sulfur programme are the evaluation and manipulation of selected appropriate S-containing products from the existing range of materials for the purpose of identifying options for various agroclimatic zones and cropping systems which could be feasibly incorporated into existing or planned fertilizer production facilities in developing countries.

2.4.4. Socio-economic and policy

Given the multidisciplinary problem-oriented operations of the Centre, the socio-economics staff make a contribution to programmes at both the farm and policy levels. Work at the farm level aims:

- to establish a strong farm-level data base for in-depth policy-oriented analyses of the farmer circumstances and behaviour in relation to fertilizer and other inputs use, agricultural production, and acceptance of new fertilizer technologies in the presence of various types of physical and economic constraints;

- to provide information (feedback) to economists, engineers, soil scientists, and agronomists involved in the development and evaluation of fertilizer technologies and public policy analysis.

Detailed and in-depth farm surveys are carried out in areas where there is a potential for food and agricultural production to be expanded by implementing policies directed to increase the economically sound use of fertilizers. Also areas are surveyed which are representative of the locations where IFDC is testing new fertilizer technologies.

Results about the agronomic performance of modified fertilizer products and/or fertilizer use technologies, obtained in field testing, are used in conjunction with appropriate prices and costs to determine and compare the profitability of these technologies under diverse agroclimatic environments. Analysis of risk associated with the use of conventional and modified fertilizer products is an important component in evaluations. In the case of phosphate fertilizers, residual effects are included in the agronomic and economic evaluation of fertilizer products.

On the public level, government intervention in the fertilizer sector is widespread in most developing countries. Governments will continue to play an important role in expanding the contribution of fertilizer to economic development by manipulating the potential macro economic consequences through public policy and by facilitating development, transfer, and ultimate adoption of fertilizer technology. This public level policy work has four objectives:

- ex-ante assessment of the macro-economic impact of fertilizer research and generation of information relevant for establishing fertilizer research priorities;

- ex-post evaluation of the macro-economic consequences of fertilizer technology and its compatibility with national goals and resource endowments;

- identification of principal national fertilizer policy issues, determination of potential fertilizer policy alternatives, evaluation of their macro-economic consequences, and development of guidelines for public policy formulation to achieve stated national goals, including an efficient and equitable use of fertilizer and national resources;

- development of research frameworks, methodologies, and models for fertilizer policy analysis for use by researchers in national institutions.

Such economic analysis is based on primary and secondary data at both micro and macro levels. The information generated by agronomic

research, economic evaluation research, farm-level economics research, and national programmes are necessary for different aspects of public policy and macro economic analysis. The most important components are fertilizer technology policy, fertilizer price and subsidy policy, and fertilizer supply and trade policy.

2.4.5. Modeling

IFDC has collaborated with the USDA-ARS crop modeling group in Temple, Texas, the IBSNAT project coordinated by the University of Hawaii, and the crop modeling groups located at Michigan State University and the University of Florida. The collaborative efforts have stemmed from IFDC's desire to use well-tested, user-oriented crop models which could work in diverse locations in the developing world. To date, these collaborative efforts have led to the refinement of the CERES-WHEAT and CERES-MAIZE models and the release of models for sorghum, millet, and rice. These models are capable of simulating the growth, phenology, water, and nitrogen balance for these crops in any region where they are grown. IFDC's specific role has been to develop the nitrogen submodel and, where appropriate, provide inputs in model development strategy in other areas in which plant nutrition has an impact. Extensive testing of the models has been performed and they have proved to be reliable over a wide range of climatic, edaphic, and cultivar environments. They have been well received by the scientific community leading to numerous applications in many diverse areas including risk analysis. The incorporation of nitrogen loss processes in these models (volatilization, denitrification and leaching) represent a major contribution to the world's crop modeling efforts.

As other crop models have been developed, IFDC is collaborating in developing a matching nitrogen component to add to these models and, where possible, in coordinating their testing. A phosphorus submodel is currently being developed which will enable simulating crop growth when water N and P are limiting systems. This model is at an early stage of development. As development proceeds, it will be incorporated into each of the crop models to enhance the scope of testing of the models.

Crop-specific modeling is conducted in cooperation with international centres in addition to the previously named US cooperators: barley with ICARDA, sorghum and millet with ICRISAT and rice with IRRI.

No modeling work has been done on fertilizer manufacturing. Expert systems or simulation models would be very helpful in pinpointing problems in fertilizer plants.

2.5. Technical assistance

IFDC operates two levels of technical assistance activities; those associated with IFDC's planned programme of activities, and those arising from developing countries in response to requests for technical assistance.

Technical assistance is an essential and integral component of IFDC's overall programme. It is one of IFDC's principal means of transferring to developing countries those fertilizer supply and use technologies developed by IFDC and others, which can raise the level of performance of national fertilizer sector operations and to assist farmers in developing the maximum benefits of fertilizer use.

IFDC's technical assistance activities are broad in scope and directed to all facets of fertilizer production, marketing and distribution, and use. Fertilizer sector policy planning and institutional development are equally important areas of technical assistance.

The primary recipients of IFDC's technical assistance include government ministries, international and regional development organizations, national and regional fertilizer associations, and private sector fertilizer producers. For the most part, IFDC's technical assistance is provided on a reimbursable-cost basis. Implementation of IFDC's technical assistance projects is based on a careful multidisciplinary assessment of the terms of reference and this gives the basis for the programme of work and budget.

The wide range of projects handled leads to the situation where one person may handle a whole project as a desk or laboratory study, or a full team of multidisciplinary specialists are needed for a period of up to 3 months overseas. The longest running technical assistance project, the IFDC/BADC Bangladesh Project, has a resident marketing specialist, trainer/agronomist, and policy economist with constant backstopping from IFDC Headquarters.

Since its establishment in 1974, IFDC has undertaken some 300 technical assistance projects, including fertilizer production (161), fertilizer use (30), fertilizer marketing and distribution (38), and fertilizer sector planning and institutional development (48). During 1975-88, fertilizer production-oriented projects have accounted for nearly 60% of the whole projects. These projects have been provided to over 150 clients and benefited 77 countries, located mainly in Asia (21), Africa (26), South America (10). The number and types of technical assistance activities that IFDC has undertaken are dictated by the requests it receives as well as the availability of IFDC staff to provide such services.

The projects on "fertilizer production" addresses the wide diversity of technical problems that developing countries face in planning, building, and operating fertilizer plants. Many developing countries are beginning or continuing exploration programmes to locate raw material deposits and to determine how they might best be used in manufacturing fertilizers which meet the needs of local agriculture. Accordingly, agromineral resource evaluation projects have been conducted in Colombia, Brazil, Saudi Arabia, and Togo. There are also fertilizer manufacture projects in India, Nigeria, Venezuela, etc.

In the projects on "fertilizer use" emphasis has been placed mainly on increasing the low nitrogen use efficiency of urea and on using locally available phosphate rock. These include the projects in Bangladesh, Egypt, India, Kuwait, Malaysia, Mali, Niger.

The projects on "fertilizer marketing and distribution" have normally centred on developing least-cost transport systems and distribution networks. These include the projects in Indonesia, Nigeria, Venezuela, etc.

The projects on "sector planning and institutional development" put emphasis on formulating and/or reviewing national and regional fertilizer supply policies and plans to developing and implementing comprehensive long-range fertilizer strategy studies, and on organizing and managing the institutional apparatus which is necessary to support fertilizer sector development and operation. These include projects in Bangladesh, Brazil, Cameroon, Egypt, Venezuela, etc.

Some of the achievements of IFDC's technical assistance project include the improvement of plant operation in Brazil, Colombia, Indonesia, Malaysia, Nigeria, Venezuela, etc. Characterization and use of indigenous phosphate rock in phosphate fertilizer manufacture has been very important to developing countries concerned with the utilization of their natural resources. Assistance on improving fertilizer use recommendations has benefited organizations in many countries. IFDC's technical assistance on improvements in the operation of fertilizer marketing and distribution systems has also contributed to the related activities in many countries.

2.6. Training

The central thrust of IFDC's training activities is to build within the developing countries a reservoir of skilled professionals capable of planning, organizing, and managing the basic components of their fertilizer sectors in a proficient manner. The objectives of IFDC's training programmes are to improve, through better trained manpower, the operation and cost-effectiveness of national fertilizer supply and marketing systems, and to promote fertilizer use and use efficiency. Its training programmes encompass virtually all facets of fertilizer manufacturing, marketing and distribution, and use. IFDC's training programme comprises general (group) and specialized (customized) training programmes. Since its establishment, IFDC has conducted 84 general and 222 specialized training programmes for approximately 3,500 participants from over 100 developing countries.

The general training programme includes formal training courses, workshops, and study tours. Most courses focus on a particular fertilizer sector function such as production, marketing and distribution, and use. The general training courses are usually open to all qualified applicants, with a particular emphasis on junior and middle-level managers and technical personnel. Fees for participation in general training programmes depend on the period, these currently range from US$ 500 to US$ 2,250. These fees partially defray IFDC's cost of their implementation. The type and nature of training programmes offered by IFDC are determined by IFDC staff specialists who are knowledgeable in training needs of individual developing countries. Training programme content and training techniques are continually monitored and upgraded and new programmes are periodically introduced to keep pace with the latest innovations in fertilizer sector development and operation. IFDC's training programme faculties are drawn

principally from IFDC's staff of subject matter specialists, and by specialists from the developed and developing countries. Training programmes feature lectures by IFDC and guest faculty. Classroom activities are complemented by field trips to fertilizer plants, sales outlets, research centres, farmers' fields, etc. Training programmes utilize advanced training techniques, including an IFDC-developed computer-assisted simulated marketing exercise, case studies, etc. A workshop atmosphere with strong participant involvement is encouraged. Venues for programmes of global interests are generally at IFDC Headquarters and usually include field trips to other US locations. More regionally focused training programmes are held at conveniently accessible locations in Asia, Africa, and Latin America. General training courses range in length from several days to up to 6 weeks; however, most are of about 2-3 weeks duration. IFDC recognizes the need for and actively seeks a wide-based support for its training activities. In this respect it continues to develop cosponsorship and cooperation from the IARCs, international and regional organizations, national government institutions, public and private sector companies, and fertilizer industry associations.

Specialized training programmes are specifically developed, upon request, to meet the unique needs of individuals or groups of individuals having common training objectives. Specialized training programmes cover a broad spectrum of fertilizer production, marketing, and use-related topics. Length of training varies greatly from a few days to one year or longer. These have been carried out at IFDC Headquarters and more recently at IFDC's Africa Research Centre in Lomé, Togo, and also at developing country locations. Fees for specialized training programmes vary with the length of the programme, its number of participants involved, and the nature of the training offered.

IFDC's general training programmes have provided training opportunities to about 1,850 individuals from 114 countries in 84 courses. During the last 5 years, general training programme offerings have varied from 9 to 13 courses annually. Annual attendance ranged from 170 to 281 and averaged about 214 per year, and participants represented between 50 and 60 countries. In respect to numbers of participants, Asia with 58% had the highest representation followed by Africa with about 23%. From a country participation perspective, Africa was highest with 41 countries followed by Asia with 28 countries. Since 1975, over 1,000 individuals have taken part in 222 specialized training programmes. Over 50% of the participants have come from Asia and nearly 40% from South America.

The important and increasing role of women in agriculture and fertilizer-related activities in many developing countries is reflected by their increased attendance at IFDC's general training programmes in recent years. From 1977 through 1988 a total of 116 women have taken part in IFDC's general training programmes, accounting for about 5% of the total number of participants during that period. Attendance has trended upward, leveling off at about 20 women participants per year during the past 3 years.

All IFDC's training programmes are subjected to participant's evaluation in order to gauge participant's view as to relevance and utility of individual programmes and to assist IFDC in improving course

content and conduct. Additionally, IFDC's general training programmes have been reviewed by missions appointed by UNDP which provides funding to support them.

The success of IFDC's human resource development effort is ultimately measured by the impact of its training on the post-training roles and activities of participants in their respective fertilizer sectors. A post-training impact study of some 744 participants in 34 training programmes conducted from 1977 through 1984 revealed that most respondents found IFDC training directly related to their work. Further, IFDC training had helped over 40% in being promoted or changing jobs, and it also has had a considerable multiplier effect in that the training materials issued by IFDC are widely used as resource materials.

2.7. The Africa Programme

One of IFDC's long-time goals of establishing regional fertilizer centres in developing countries was realized in 1987, when the Centre opened its Africa Division in West Africa (Lomé, Togo), with a planned East African liaison office.

The establishment of a regional centre in Africa is not a new idea. In fact, in 1982 the organization of African Unity/Scientific Technical and Research Commission (OAU/STRC) selected IFDC to serve as executing agency for planning, formation, implementation, and operation of an African Centre for Fertilizer Development (ACFD) to be located in Harare, Zimbabwe - for a period of 5 years or longer.

The overall objectives of ACFD, as outlined in the planning document, are to improve and stabilize the agriculture of Africa through proper production and use of fertilizers and to make maximum use of Africa's indigenous materials and resources.

The establishment of the ACFD has yet to materialize because of delays within the OAU system. However, once the OAU gives approval to the creation of ACFD, IFDC is prepared to manage the operation of this Centre through the use of appropriate in-house expertise and consultants. Anticipating that ACFD would soon be operative and that IFDC would be the executing agency the activities in Africa have been handled out of the Managing Director's Office.

2.7.1. East and Southeast Africa

There is only one project that is a continuing activity in EAst and Southeast Africa, namely the "Fertilizer Research Programme in East Africa". Its objective is to coordinate an effort to promote the production of indigenous fertilizer resources, to enhance the use of fertilizers in increasing fertilizer production, to improve sector performance, and to strengthen the capability of national agricultural research organizations in the field of fertilizer research. For 1988-89, short-term projects are active in Burundi, Kenya, Malawi, Tanzania, Uganda and Zambia.

2.7.2. IFDC-Africa

About 1984, IFDC received an expression of interest from Togo in their hosting a centre for West Africa. It was understood by IFDC and its Board that should a centre in Togo become a reality, it would work closely with the ACFD with the possibility that the two centres could conceivably be merged at a later date; once the Zimbabwe centre was established and operating.

An agreement with Togo provides IFDC the privileges and immunities of any other international organizations. Togo provided a 12-hectare tract of land that can be used for building IFDC-Africa's Headquarters. In addition, they are providing five experimental sites of 10-20 hectares each in different ecological zones in Togo.

At present, IFDC-Africa has a senior international staff of 13 people. The projects handled by IFDC-Africa are listed in Annex 2.7.2.

2.7.3. Egyptian Fertilizer Development Centre (EFDC)

In 1988 Egypt decided to establish an Egyptian Fertilizer Development Centre (EFDC). IFDC is functioning as a contractor to UNIDO and will advise in the management of this Centre. The EFDC will first be solely a national research and development centre. There is a stated desire that at a later date this Centre will serve other countries in the region.

2.8. Support Programmes

2.8.1. Information and Communication

Its Communication Department is in charge of publishing IFDC literature including technical bulletins, reference manuals, circulars, special publications, a paper series, general publications, selected proceedings of IFDC-sponsored symposia and workshops, and fertilizer situation reports. IFDC publications are entered in the Books in Print data base and catalogued by the Library of Congress. A brochure listing all of IFDC's publications is available.

The newsletter in English, French, and Spanish is distributed gratis to over 4,000 recipients each quarter and the number is growing.

Since its inception, IFDC has produced 396 publications (31 technical bulletins, 7 reference manuals, 10 annual reports, 11 special publications, 11 paper series, 6 promotional publications, 4 fertilizer situation reports, 127 articles on nitrogen, 81 articles on phosphate, 13 articles on sulfur, and 94 articles on miscellaneous subjects).

2.8.2. Library

The IFDC library provides information services support for all IFDC research, technical assistance and training activities. The IFDC

library shares the TVA library holdings which include over 27,000 books; agricultural, chemical, and scientific printed indexes and abstracts; and over 1,100 technical journal subscriptions. IFDC scientists also have access to the TVA current awareness service.

The library collection consists of over 10,000 volumes of books, journals, pamphlets, and audio visuals. IFDC subscribes to or receives complementary issues of 250 journals and newsletters. A country file which includes fertilizer-related documents, state and agriculture-related reports of 125 different countries is maintained. An organization file contains material published by approximately 290 different organizations that are related directly or indirectly to studies or projects involving developing countries. The library collection also includes a bibliography file, conference file, and a training programme file. IFDC has assisted in establishing libraries in Bangladesh, Brazil, Indonesia, and the Philippines among others.

Requested books, journal articles, and materials that are not available locally can be obtained for IFDC scientists through the linkage of the library computer and OCLC. This national network allows access to the holdings of over 3,000 libraries.

IFDC's library subscribes to an information service called DIALOG. This system supports more than 300 data bases that cover topics ranging from agriculture and nutrition to the latest scientific technological innovations.

2.8.3. Data Bases

IFDC maintains several data bases of global, regional, and national fertilizer data.

- Fertilizer Evaluation Programme and Information System (FEPIS)
  This programme provides guidelines and technical assistance for systematic agronomic and economic evaluation of fertilizer products and fertilizer management practices in the diverse agroclimatic environments of the tropics and subtropics. There are three main components: a fertilizer data base system; data analysis and modeling services; and fertilizer efficiency information system.

- Fertilizer Raw Materials Data Base
  The FRMDB consists of two components: fertilizer raw material reference data; and chemical and mineralogical data on phosphate rocks.

- Other Data Bases
  Outreach Division maintains several data collections initiated from 1976, related to fertilizer production, consumption, and prices. The currently maintained systems are: farm-level prices, fertilizer price expectations, international prices, FAO data, production capacity, planned surveys, and studies and dissemination.

This data collection and analysis activities provide a resource which is used by IFDC for policy studies, technical assistance, and

training and by other agencies such as AID, World Bank, donor agencies, and developing country fertilizer sector association and grouping.

2.9. The Regional Distribution of Programmes

IFDC aims at a wide applicability of its research results rather than at solving site-specific problems. Research is geared to the major constraints encountered in each of the major agro-ecological zones such as acid soils in the tropics of South America, efficient fertilization of irrigated rice in Southeast Asia, low fertility status and drought hazards of soils in parts of Africa.

IFDC's research is mainly carried out in its headquarters at Muscle Shoals, in its regional centre at Lomé, and through outposted officers in Bangladesh, Colombia, Niger, Philippines, and Zimbabwe.

The distribution of IFDC's technical assistance (1975-88) is as follows: Asia (31%), Africa (28%), Latin America (37%), Europe (2%), and Oceania (2%).

The general training programme (1975-88) shows the following distribution of participants: Asia (57.9%), Africa (23.3%), Latin America (17.1%), Europe (1.4%), and Oceania (0.3%).

For the specialized training programme (1975-88) the distribution is as follows: Asia (56.3%), Latin America (39.4%), Africa (3.1%), and Europe (1.2%).

2.10. A 10-Year Plan

The design and structure of IFDC's programmes and their implementation is based on several considerations:

- IFDC's mandate to focus on research, development, and transfer of appropriate fertilizer technology and related know-how to increase and sustain food production and promote the use of indigenous resources in developing countries of the tropics and subtropics;

- the present world agriculture and fertilizer situation and the influence that expected changes in this situation will have on the needs of developing countries for fertilizer technology and know-how;

- the presence of interregional as well as intraregional diversity in the nature of problems and needs of developing countries for fertilizer technology and know-how;

- plans and priorities of international and national organization involved in agricultural research and development;

- priorities of donors and funding agencies affecting the availability of funds to conduct activities which are within the mandate of IFDC;

- objectives of overall efficiency for IFDC to carry out its mandate in a technically and economically effective way to enhance its comparative advantage and expand its role in international agricultural development.

New areas of focus anticipated over the next 10 years include:

- the identification, characterization, and evaluation (technical, agronomic, and economic) of a wider range of agrominerals, e.g., liming materials, sulfur, potash, and other plant nutrients;

- environmental issues related to the production and use of fertilizers;

- the expansion of crop modeling and the simulation of production processes;

- the development of cost-effective fertilization practices for sustainable agriculture, widening out from purely inorganic sources.

The programmes will take a problem-solving approach to fertilizer-related agricultural development issues of long-term importance to developing countries. Programmes will continue to be multidisciplinary in nature and be designed to include components of basic and applied research as well as technology transfer, information dissemination, and training.

3. RESEARCH RESULTS AND IMPACT

IFDC, in its 15-year existence, has produced a series of important research results for tropical and subtropical agriculture. Many of these results are beginning to have positive impacts at the country or farmer level, although most are at early stages of payoff. Given the collaborative nature of virtually all of IFDC's activities, recognition of success is to be shared with other institutions. Nevertheless it is certain that most of it would not have materialized without IFDC's involvement and leadership.

3.1. Research Results

IFDC's main research contributions can be summarized as follows:

(1) The importance of ammonium volatilization as the principal loss pathway of applied nitrogen on flooded rice was demonstrated and quantified. Major methodology advances are an important byproduct of this research.

(2) Deep placement of urea supergranules was found to be the most cost-effective approach for improved N-use efficiency in flooded rice soils. Average N-use efficiency can be increased from 30% to 60% with this technology.

(3) Urea supergranules can be made most economically by briquetting (either at the village level or by large plants). This brings this technology within easy reach of many small farms.

(4) The high labour input involved in deep placing urea supergranules can be reduced by the use of the IFDC applicator combined with line transplanting.

(5) Commercially-available coated fertilizers are not cost-effective for Asian rice farmers.

(6) A new urease inhibitor N-(n-butyl) thiophosphoric triamide "nBTPT" has been found to decrease urea volatilization losses to less than 10% in both flooded and well-aerated soils, as opposed to the normal 40% level. This inhibitor is more effective than currently available ones and lasts several times longer in the soil. Its cost effectiveness is still to be evaluated.

(7) Denitrification in tropical paddy soils, when directly measured with a new IFDC technique, is generally less than 3% of the applied N. This is a much lower figure than current estimates using indirect methods. This information has important implications about the contribution of nitrous oxide emissions to global warming estimates.

(8) A new slurry production process permits phosphate rock to be carrier of Rhizobium inoculum. If proven viable at the field level, this combination could be a most useful one for low-input systems in acid soils of the tropics where legumes are grown.

(9) IFDC has established a computerized raw material data file on about 1,200 phosphate ore samples from 75 developing countries. This information is highly valuable to plan a strategy for processing the material to a phosphatic fertilizer or for direct application. Many countries are now much better informed on their phosphate resources.

(10) IFDC is well equipped to perform research on phosphatic raw materials, intermediate and final products such as suitability studies of P ores to the manufacture of phosphoric acid, MAP or DAP and nitric phosphate.

(11) For low-reactivity phosphate rocks, IFDC has developed technology for partial acidulation using sulfuric or phosphoric acid which will enable the use of rocks not suitable to conventional technologies.

(12) IFDC has adopted tests to define the required parameters to evaluate urea-based NPK productions.

(13) IFDC has developed technology for compaction to make granular NPK plus micronutrients. Its advantages appear strong for certain developing countries. Economics also appear favourable.

(14) IFDC is in the advanced stages of developing a radically new soil test for phosphorus which is not specific to soil conditions of

fertilizer source and is sensitive to low available P levels common in low-input systems. If validated, this procedure could make a major contribution to fertilizer efficiency.

(15) No significant breakthroughs are yet available from the sulfur programme.

(16) The incorporation of nitrogen dynamics into crop simulation models is a major conceptual advance, making such models more realistic since nitrogen is really limiting in most agricultural soils.

3.2. Impact

Thanks to its research and data files, IFDC has become a world leader in fields like characterization of P minerals and application of them either directly to acid soils or through partial and full acidulation or even converted to phosphoric acid, MAP or DAP. Its capabilities are especially valuable in helping in the beneficiation of difficult ores which in other cases would be of no use.

More than a dozen developing countries are using IFDC phosphate technologies and many other countries are at advanced steps of decision-making studies for implementing projects based on IFDC's technologies.

Nitrogen research offers less immediate impact. Production technologies developed by IFDC are more expensive or require extra labour or may be based on products which are not commercially available. Although it has been demonstrated that those technologies sharply increase the N use efficiency by the crop, it will take time until extensive application is achieved. IFDC's modeling research brings insights of the level of risk in nitrogen use in high risk environments.

Sulfur research is still at the stage of receiving feedback information from agronomists although major changes in sulfur use are apparent in Bangladesh as a direct result of IFDC involvement.

An impact down the road is the urea supergranule technology which is shown to double the efficiency of nitrogen fertilizer use in irrigated rice. With conventional urea, 30% of the N applied is taken up by plants, 30% is immobilized by soil micro-organisms, and 40% is lost to the atmosphere and waterways. With urea supergranules, 60% is recovered by plants, 30% is immobilized by soil micro-organisms, and only 10% is lost to the atmosphere and waterways.

At present, very little of this technology is utilized by farmers, in part because of the classic chicken-and-egg situation facing a new product: companies do not manufacture them because there is no market, and there is no market because farmers cannot test the material. Assuming this bottleneck is overcome there will be considerable savings of nitrogen fertilizer in Asia.

4. GOVERNANCE, MANAGEMENT, AND METHODS OF OPERATION

4.1. Governance

IFDC governance is provided by a 15-member Board of Directors, drawn from 12 different countries. Seven members are from the developing world, four from the United States, and four from other developed countries. (Note: It is expected that with turnover in Board membership, the number of Directors from the United States will be reduced to three in the near future.) The current composition of the Board is reflected in Annex 4.1. There is one developing country vacancy at this time.

Three of the Board members are nominated by the CGIAR and two by USAID. All members are recognized leaders in government, academic institutions, international organizations, and business. Directors are elected for a three-year term with provisions for reelection to additional terms. In practice, Directors usually serve no more than two terms.

The Managing Director serves as an ex-officio member of the Board. The Administrative Director of the Centre serves as the Board's Secretary/Treasurer. A USAID representative usually attends meetings of the Board, reflecting that agency's long-time interest in the Centre as a major donor.

4.2. Management and Methods of Operation

The Board of Directors is responsible for overall policy guidance and approval of the annual budget. Responsibility for day-to-day operations of the Centre is vested in the Managing Director. The Board sets programme priorities and evaluates progress. The Board has Executive and Programme Committees which perform functions similar to those respective committees in other IARCs. The Board meets annually for a period of 3-5 days.

With the creation of the IFDC-Africa Division, the Board also established a special (Africa) Committee to give programme guidance to the operations of that Division. Common Board members serve on both the Programme and African Committees to help facilitate the integration of Headquarters and Africa activities.

The Centre is organized into four programme divisions: Fertilizer Technology, Agro-Economic, Outreach, and Africa. Administrative and support functions are placed under the Office of the Managing Director (OMD).

The annual budgets, programmes, and staff requirements are developed by the respective Division Directors in collaboration with senior staff members and the Deputy Managing Director. Division budgets are then adjusted, if necessary, by the Managing Director in light of the projected revenue. Once the budgets and programmes are approved, the Division Directors are responsible for the operation of each Division.

The activities of the four Divisions are coordinated through the OMD. The OMD is responsible for programme development, communications, fund raising, and routine administrative and budgetary functions. In addition, the OMD coordinates the Centre's activities in East Africa, pending the establishment of an office in that region.

4.2.1. Fertilizer Technology Division

The major activities of this Division involve (1) work with problem phosphate ores, including research to find ways to make these ores more useful, (2) formulating and providing experimental fertilizer materials for greenhouse and field testing, (3) providing technical assistance relating to fertilizer product and supply to specific institutions, and (4) participating in training programmes. All activities except technical assistance are usually conducted in cooperation with other Divisions. Technical assistance may be provided independently or in cooperation with the Outreach Division. A major part of the Fertilizer Technology Division's activities involve special projects which may or may not be tied to the efforts of the other Divisions.

4.2.2. Agro-Economic Division

This Division's efforts are directed toward research to identify agronomic, economic, and sociological problems related to technology transfer and fertilizer use, as well as the development of means to solve these problems. Economic research focuses on the economic evaluation of new fertilizer products and practices; the study of constraints to adoption, usage, and demand for fertilizers; and the analysis of public policy and international issues relating to fertilizer usage. The agronomic research component involves laboratory and greenhouse research at IFDC Headquarters and field research in different countries and agroclimatic environments.

4.2.3. Outreach Division

This Division is responsible for developing human resources needed by the fertilizer sector of developing countries. It also identifies regional and global problems, facilitates the transfer of relevant technology, provides market development assistance, and helps develop national institutions that will adapt technologies to local conditions.

4.2.4. Africa Division

The efforts of this Division, which is located in Togo, are directed primarily toward the needs of West African countries. The Division is involved in research and development, training, and technical assistance covering agronomy, production and use technology, marketing, economics, and sociology.

The Division operates under a Director who reports to the Managing Director. Although the Division has functions similar to the

other three Programme Divisions, centred at the Headquarters unit in Muscle Shoals, these functional activities do not come under the jurisdiction or responsibility of these other Divisions. Close collaboration is apparent.

Although not a part of the Africa Division, as presently constituted, reference should be made to other Africa initiatives which may ultimately affect the IFDC programme on that continent. These other initiatives are reflected in section 2.7. of this report.

4.2.5. Administrative and Support Functions

Most administrative and support functions of the Centre are organized under the OMD, reporting to and through the Administrative Director for the Centre in that office. The functions include the following units or activities: Accounting, Purchasing, Personnel, Word Processing, Central Files, Mail Room, Library, Communications, and Visitor Relations. Computer operations are under the Agro-Economic Division and maintenance functions are the responsibility of the Fertilizer Technology Division.

4.3. Relations with other Institutions

IFDC has developed close, collaborative relationships with other institutions in both developing and industrialized countries. The following are some specific examples of such collaboration.

4.3.1. National Programmes

IFDC suggests that one area of its uniqueness is its ability to assemble key expertise in the production, marketing, and use of fertilizers and organize this expertise as multidisciplinary research teams to help solve specific problems. The Centre uses such an approach in efforts to assist developing country programmes. For example, a current IFDC project in Bangladesh involves personnel from several disciplines including agriculture, industry, and marketing - working in concert with appropriate government ministries. A similar project is now evolving in Egypt.

IFDC has also established collaborative research with several national institutions, particularly in sub-Saharan Africa. These include the West Africa Fertilizer Management and Evaluation Network (14 countries), the East Africa Fertilizer Management and Evaluation Network (14 countries), the Geology Network for East and Southeast Africa (14 countries), the Geology Network for West Africa (14 countries), and the West African Fertilizer Marketing and Information Network (8 countries).

In addition to such networks, the Centre is involved in numerous specific projects and programmes involving collaboration with national institutions.

4.3.2. International Agricultural Research Centres

Over the past 14 years, IFDC has established formal collaborative programmes with 6 other IARCs - ICRISAT, IITA, IFPRI, CIAT, ICARDA, and IRRI. The Centre is now exploring opportunities for collaboration with both CIP and CIMMYT.

Currently, two IFDC staff members are outposted at ICRISAT in Niger, one with ICRISAT in Zimbabwe, one at CIAT, and one at IRRI. An IFPRI staff member is outposted at the IFDC-Africa Programme in Togo. Until 1987 an IFDC staff member was outposted at ICRISAT in India. At one time there was also outposted staff at IITA. There has been collaboration with ICARDA and other centres, both in research and training programmes, not involving outposted personnel.

The work with other centres has, at times, involved collaboration with the national programmes as well. For example, IFDC cooperated with IRRI in establishing the International Network on Soil Fertility and Sustainable Rice Farming (INSURF), an outgrowth of a longstanding international working group on tailoring fertilizer to the needs of rice. IFDC work with CIAT involved research collaboration with national scientisits in Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Mexico, Peru and Venezuela.

4.3.3. Advanced Institutions

IFDC has had limited interactions with more advanced institutions in industrialized countries. The nature of the Centre's programme has called for developing primary relations with industry in industrialized and developing countries and with agricultural institutions in the developing world. However, there has been some cooperation with US universities in training and research programmes.

Perhaps the most significant and extensive collaboration with a more advanced institution has been with the National Fertilizer Development Centre (NFDC) located at Muscle Shoals, Alabama. This relationship, discussed in section 1.1. of this report, appears extremely positive, productive, and beneficial to IFDC; indeed it is a relationship that would be difficult to duplicate at any other location in the world.

4.3.4. Fertilizer Sector

IFDC has been involved in extensive collaborative efforts with organizations related to the fertilizer sector, both public and private. For example, the Centre has worked with fertilizer companies in a number of developing countries including Bangladesh, Brazil, Burkina Faso, Burundi, Cameroon, Chile, Colombia, Costa Rica, Egypt, India, Indonesia, Israel, Jordan, Kenya, Malaysia, Mexico, Niger, Nigeria, Pakistan, the Philippines, Saudi Arabia, Senegal, Sri Lanka, Tanzania, Togo, Venezuela, and Zambia. This collaboration has involved technical and fertilizer use work with the industry in both the public and private sectors.

IFDC has also worked with a number of international and national trade associations and industry-related organizations in both developing and developed countries, sharing fertilizer production, marketing, and use information. Following are examples of such organizations: the British Sulphur Corporation (BSC), International Fertilizer Industry Association (IFA), World Phosphate Institute (IMPHOS), the Fertilizer Institute (TFI), Fertilizer Association of India (FAI), America Phosphate Foundation (APF), Potash and Phosphate Institute (PPI), and the Fertilizer Advisory Development and Information Network for Asia and the Pacific (FADINAP).

In some cases, IFDC has hosted joint training programmes involving organizations such as FAI and FADINAP. Recently IFDC initiated a research programme in West Africa in collaboration with IMPHOS and APF.

4.3.5. United Nations Organizations

In addition to receiving significant financial support from UNDP for research and training programmes, IFDC has actively cooperated with other UN agencies. For example, the Centre has worked with FAO in training programmes as well as in the evaluation of fertilizers in the FAO fertilizer programme. Moreover, IFDC participates in the FAO/UNIDO/ World Bank fertilizer working group that meets at least once annually to discuss and formulate fertilizer supply/demand balances. Recently, IFDC has worked with FAO in the dissemination of marketing-related fertilizer information to selected sub-Saharan African countries.

5. A PROFILE OF THE CENTRE'S RESOURCES

5.1. Physical Facilities

The IFDC is located on a 13-hectare tract of land adjacent to the National Fertilizer Development Centre (NFDC) of the Tennessee Valley Authority (TVA), but these organizations are independent of each other. The IFDC has its own facilities, although it can and does use TVA's cafeteria, medical centre, library, and warehouses as needed. IFDC partially funds the TVA Technical Library at Muscle Shoals, which holds perhaps the most extensive collection of literature on fertilizers in the world. TVA also provides security, fire protection, grounds maintenance, some utilities, and some fertilizer raw materials and intermediates to IFDC on a cost basis.

The IFDC-Africa in Lomé, Togo, is temporarily housed in rented buildings that provide offices. A 12-hectare parcel of land, near Kpeme and adjacent to the Office Togolaise de Phosphates (OTP) production facility (approximately 35 km from Lomé), has been given to IFDC by the Togolese Government as the permanent building site for the IFDC-Africa. Field test sites with various soil and agroclimatic conditions also are available for agronomic trials in Togo for periods of up to 10 years when they will be exchanged for other sites where fertility trials have not been conducted.

The IFDC Headquarters facilities were completed in 1977 and have about 8,000 m^2. The complex includes two buildings. The main building consists of an administration wing, the outreach/training centre, the laboratory wing of the Agro-Economic and Fertilizer Technology Divisions, a headhouse wing, and the greenhouses of the Agro-Economic Division. The basement also serves such functions as data processing centre, electrical and mechanical workshops, mail room, purchasing, garage and storage. The pilot-plant building consists of laboratories, pilot-plant area (laboratory- and pilot-scale granulation plants, a wet/dry beneficiation plant, and a wet process phosphoric acid plant), warehouse, hazardous and non-hazardous chemical storage, controlled temperature humidity room, sample preparation room, crushing room, mechanical/electrical room, maintenance shop, shipping/receiving area, and a small conference room. A settling pond is located at the rear of this building.

5.2. Staff Resources

During the past 14 years the IFDC staff has rapidly grown from 50 in 1976, to about 150 in 1989. The present staff is recruited from 25 countries and is both internationally and technically diverse. While most of the staff is located in Headquarters, IFDC has about 20 senior staff members in host countries that include Bangladesh, Colombia, Niger, the Philippines, Togo, and Zimbabwe.

IFDC has a substantial administrative support staff of typists, computer specialists, communication/media specialists, and others who are pooled to aid the professional staff in the divisions.

The distribution of employees, identifying degree levels across the divisions, is set out in Table 5.2.1.

Table 5.2.1. Staff by Division and Qualification

Division	Ph.D.	M.A./M.S.	B.A./B.S.	Other	Total
Office of Managing Director	3	2	11	24	40
Fertilizer Technology	5	5	9	10	29
Agro-Economic	17	4	9	6	36
Outreach	8	5	8	3	24
IFDC-Africa	10	6	4	0	20
TOTAL*	43	22	41	43	149

* These totals do not include support staff at Lomé, Togo, or in other overseas stations.

The numbers of professional employees by discipline and degree are set out in Table 5.2.2.

Table 5.2.2. Disciplinary Composition

Profession	Ph.D.	M.A./M.S.	B.A./B.S.	Total
1. Agronomy/Soil Science	21	4	1	26
2. Plant Physiology	2	0	0	2
3. Chemistry	4	7	1	12
4. Chemical Engineering	2	1	4	7
5. Mineralogy/Geology	2	2	0	4
6. Economics	8	3	2	13
7. Sociology	2	0	1	3
8. Business (Accounting, Marketing, Management)	0	5	8	13
9. Other	1	7	18	26
TOTAL	42	29	35	106

Project leaders usually have 10 or more years of experience in their specialized fields with some in developing country settings, or are from developing countries. Scientists usually work with the project leaders and usually have 2-10 years of working experience, preferably some in developing countries. Research assistants/associates are recent college graduates and work under close technical supervision of a project leader.

IFDC has a few experts who specialize in communications, training, fertilizer production, marketing/distribution, and use. These specialists usually have several years of experience in public and private sector enterprises, preferably with some in developing countries. Mainly assigned to the Outreach Division, they respond to the short-term technical assistance projects and are also involved in fertilizer sector studies.

5.3. Financial Resources

5.3.1. Sources of Funds

IFDC is funded by international sources. The original sponsors of IFDC were the International Development Research Centre (IDRC) of Canada and the USAID. The latter provided the bulk of funds for physical facilities and equipment and to operate the core programmes. The cost of IFDC's physical plant and equipment was about US$ 8.7 million. The operating expenses of IFDC have steadily increased from US$ 2.0 million in 1976 to US$ 10.9 million in 1988. Table 5.3.1. shows the build up in revenue and expenditure. Following a sharp decline in 1986, when the expenses totaled US$ 7.5 million due to decreased revenues in earlier years, the budget has progressively increased since then and is projected to be US$ 12.7 million in 1989.

Table 5.3.1. IFDC Revenue Expenditure 1976-88

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
	(million US $)												
Revenue													
Core	1.9	2.1	3.9	4.1	4.0	4.3	4.2	4.2	4.9	4.4	4.2	3.8	4.1
Restricted core/ Special Projects	0.4	0.3	0.4	1.9	3.1	3.7	5.1	4.3	4.5	3.7	4.3	4.6	7.4
Total	2.3	2.4	4.3	6.0	7.1	8.0	9.3	8.5	9.4	8.1	8.5	8.4	11.5
Expenditures[a]	2.0	2.1	4.2	5.5	7.2	7.7	9.3	8.6	10.1	9.2	7.5	8.9	10.9

a. Expenditures include fixed assets less depreciation.

In addition to USAID and IDRC, other major donors are the United Nations Development Programme (UNDP); the World Bank; the German, Dutch and French Governments; and the Kellogg and Rockefeller Foundations. In the past, IFDC has also received substantial funds from the Australian Development Assistance Bureau (ADAB) and the International Fund for Agricultural Development (IFAD). IFDC does not have a donor support group.

5.3.2. Core and Special Project Funds

The IFDC budget is composed of unrestricted and restricted/ special project funds. Unrestricted or core funds are provided by donors (mainly USAID) for basic research and other tasks (e.g. administration) within the scope of the IFDC mission. These funds were about US$ 1.9 million in 1976, and rose to about US$ 3.9 million in 1978. Since then they have stayed approximately constant at slightly over US$ 4.0 million. Until 1986 IFDC received core funding from USAID at an annual rate of US$ 4.0 million. However, in 1987 this amount was reduced to US$ 3.5 million. With the establishment of IFDC-Africa (in Lomé, Togo) in 1987, some core funds are being contributed for the Africa Division by UNDP and the German and Dutch Governments.

As IFDC's budget has grown, the proportion of unrestricted funds to the total budget has shrunk from 80-90% in the late 1970s to 36% in 1989. Restricted/special project funds are given for particular projects, often in specific countries or regions. These resources come from donors or other organizations, including public and private government bodies and fertilizer companies. The duration of these projects varies, depending upon the nature of services provided by IFDC. Special project funds were small in the first years of IFDC but have progressively increased since then. In 1985, ADAB and IFAD did not extend existing special project funding. Reduced revenues required reductions in the staff. Momentum was renewed in 1987 when special project funding expanded to US$ 7.4 million in 1988.

5.3.3. Future Planned Expenditures

IFDC planned expenditures for 1989 are shown by category in Table 5.3.3.1.

Table 5.3.3.1. 1989 Planned Expenditures by Programme (US$)

Programme	Planned Expenditures Cost (US$)	% of Total Budget
Technical Assistance	2,298,827	18.1
Training	1,129,635	8.0
Research & Development*	5,137,017	40.0
Administration & Operations	3,904,575	30.7
Capital Equipment	238,780	3.4
TOTAL	12,708,834**	100.00

* This item includes restricted and unrestricted funds.
** This total includes about US$ 4.0 million for activities in Africa.

Details of the Headquarters Research and Development planned budget for 1989 is shown in Table 5.3.3.2.

Table 5.3.3.2. 1989 Planned Headquarters Research and Development Budget (US$)

Programme	Cost (US$)	% of R&D Budget
Phosphorus	680,940	19.8
Nitrogen	728,725	21.2
Sulfur	90,225	2.6
FEPIS	240,895	7.0
Marketing R&D	265,340	7.7
Engineering R&D	131,620	3.8
Research Support Services	493,720	14.4
Outposted Field Research	171,710	5.0
Technology Evaluation and Transfer at National Level (includes farm-level economics, sociological investigations, production and distribution)	393,220	11.5
Research Supervision	240,917	7.0
TOTAL	3,437,312	100.0

Operating expenses are expected to increase from a planned US$ 12.71 million in 1989 to US$ 14.01 million in 1991 and US$ 15.45 million in 1993. Budgets of the main divisions projected to 1993 are shown in Table 5.3.3.3.

Table 5.3.3.3. Five-Year Projection of Divisional Expenses (US$)

Division	1989	1991	1993
Office of the Managing Director	2,877,615	3,282,800	3,619,200
Outreach Division	3,104,965	3,423,200	3,774,100
Agro-Economic Division	1,988,328	2,192,100	2,416,800
Fertilizer Technology Division	1,613,656	1,779,000	1,961,400
West Africa	3,024,270	3,334,300	3,676,100
TOTAL IFDC	12,708,834	14,011,400	15,447,600

5.3.4. Expenditures by CGIAR Activity Categories

Proper allocation of IFDC expenditures by CGIAR activity requires more detailed analysis of the line items for Research and Development, Technical Assistance, and the Office of the Managing Director. A rough approximation is given below:

CGIAR No.	Activity	Percent
10 a	Plant Nutrition Research	20
10 b	Plant Nutrient Technology Development	15
23	Market Analysis	
24	Policy Analysis	10
15	Training	10
20	Technical Assistance	15
	Office of the Managing Director	30

6. ISSUES AND CONCERNS

IFDC expressed the desire to join the CGIAR System. The IFDC Board would need to review the conditions of entry prior to the formulation of a formal request for inclusion. IFDC would be concerned

if entry into the CGIAR should involve a significant departure from its present strategies or a loss of flexibility in its present programmes of work.

IFDC's funding consists to a great extent of non-core sources which are devoted to special projects. A number of these projects are technical assistance operations which are less common in other IARCs. It was stressed, however, that these technical assistance projects generally comprise a research component and that they are an essential element of IFDC's programmes devoted to fertilizer manufacturing and the establishment of marketing and fertilizer research facilities. It is to be noted that the great majority of the technical assistance projects directly relate to IFDC's mandate and established programme.

Given the growing interest in environmental issues within the CGIAR System and elsewhere, the question was raised concerning the appropriate balance between efforts relating to fertilizer and agricultural technology and those concerned with possible environmental consequences of fertilizer use, such as the pollution of water resources.

In recent times TAC and other elements of the CGIAR System have placed great emphasis on the need to achieve sustainable agricultural systems. Some groups in the United States and elsewhere tend to equate sustainable agriculture with low inputs of fertilizers and other chemicals. The general adoption of such a low input philosophy could result in a reduced usage of fertilizers. TAC's position is that sustainable agriculture practices do not necessarily involve low inputs. Indeed, to the contrary, there are circumstances where the achievement of sustainability goals may require high inputs. IFDC should contribute to place this issue in a proper perspective so that agricultural production be ensured while giving due attention to environmental concerns.

Annex 2.4

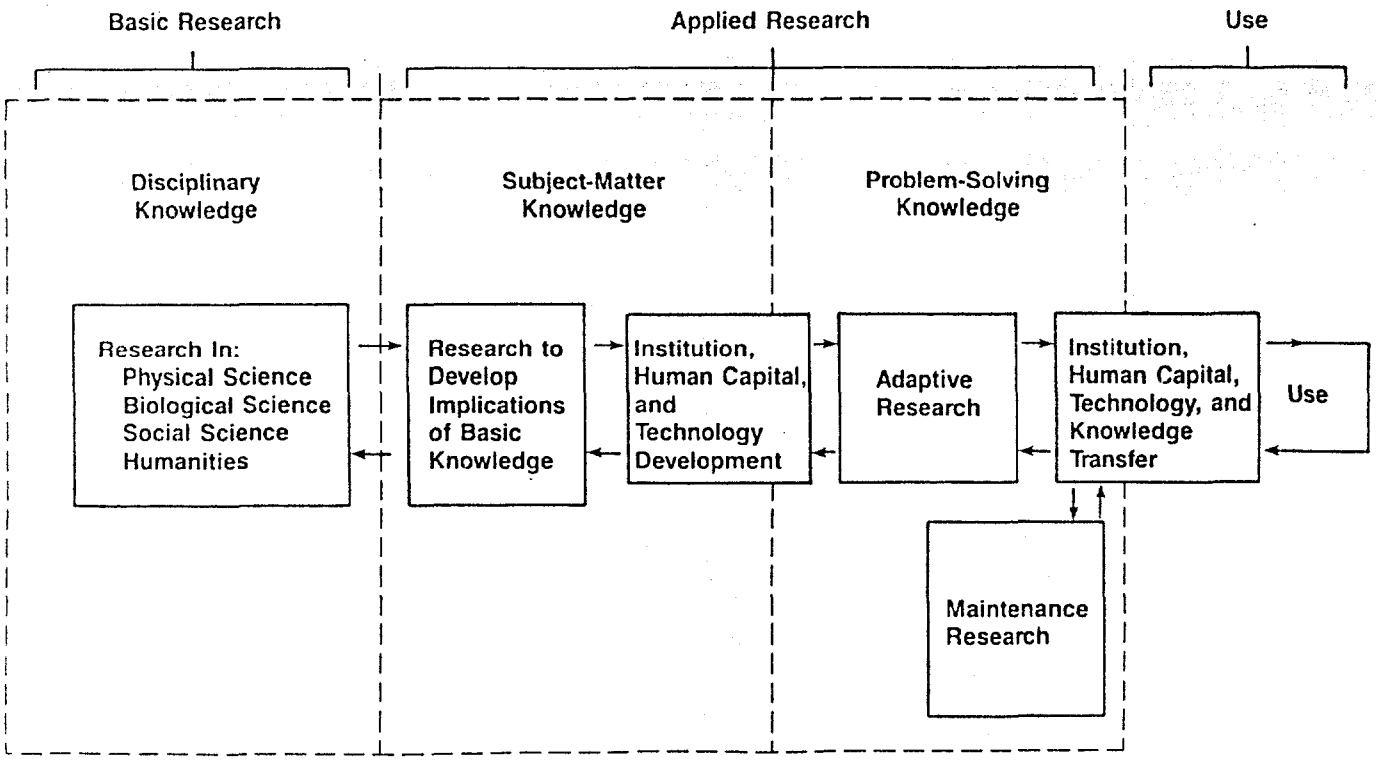

Figure 2. The Creation, Development, and Use of Knowledge.

Annex 2.6

Titles of IFDC Training Programs

Fertilizer Marketing

Fertilizer Marketing Management Training Program
Fertilizer Marketing Training Program
Fertilizer Distribution and Handling Training Program
Modern Trends in Fertilizer Distribution and Handling Training Program
Data Collection, Analysis, and Projections for National Fertilizer Sector Studies Training Program
Use of Microcomputers for Fertilizer Sector Personnel Training Program
Fertilizer Quality Control Training Program

Fertilizer Production

Fertilizer Factory Maintenance Training Program
Maintenance and Production Management Training Program
Fertilizer Granulation and Bulk-Blending Seminar
Fertilizer Production Training Program
Development of Indigenous Phosphate Deposits Training Program
Fertilizer Process Economics Training Program
Technical Management of Fertilizer Production Units

Fertilizer Use Efficiency

Fertilizer Efficiency Research in the Tropics Training Program
Soil Testing and Soil Fertility Management Training Program
Fertilizer Use Efficiency Research and Technology Transfer Workshop in Africa
Statistical and Economic Analysis of Fertilizer Experimental Data Training Program
Research on Effective Fertilizer Use Training Program
Computer Simulation for Crop Growth and Fertilizer Response Training Program

Fertilizer Sector Development

Advance in Fertilizer and Irrigation Technology in the United States Training Program
Advances in Fertilizer Technology, Marketing and Use in the United States Training Program
Caribbean Workshop on Fertilizer Technology and Marketing Systems
Fertilizer Sector Development in Tropical and Subtropical Agricultural Training Program
African Workshop on Fertilizer Sector Development
Investment Analysis and Decisionmaking--Fertilizer Sector Projects Training Program
Finance for Nonfinance Managers in Fertilizer Sector Training Program
Relevant Fertilizer Supply Strategies Training Program
Workshop on Fertilizer Sector Development and Agricultural Production for Selected Countries in the Mediterranean, Middle East, and North Africa
Fertilizer Sector Development for Graduate Students Training Program
International Workshop--NPK Fertilizer Production Alternatives

Annex 4.1

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